CHAPTER VI - TROPICAL CYCLONE SUPPORT SUMMARY

1. NAVAL ENVIRONMENTAL PREDICTION RESEARCH FACILITY

The Pocket Tropical Cyclone Model (PTCM)

(Evans, J.L., Monash University, Australia and J.H. Chu, NAVENVPREDRSCHFAC)

PTCM is a linear tropical cyclone motion prediction scheme incorporating the effects of a large-scale environmental flow and the beta-effect. The model is based on the equations developed by Holland (1983) and has been operational in a modified form in the Australian region for a number of years. The current version of the model has been developed by Evans and Holland to be a purely objective forecasting tool, and is presently undergoing operational testing in the Australian region.

PTCM is being incorporated in the NEPRF ATCF system and a series of case studies are planned to test its effectiveness in the Northwest Pacific region. In addition, the model will be expanded to include additional terms for diagnosis of tropical cyclone motions.

THE ADVANCED TROPICAL CYCLONE MODEL (ATCM)

(Hodur, R.M., NAVENVPREDRSCHFAC)

The Advanced Tropical Cyclone Model (ATCM) was installed at the Fleet Numerical Oceanography Center in 1987 for evaluation by JTWC forecasters. Although testing in 1986 indicated that the ATCM could perform better than the OTCM, these results were not obtained during real-time runs during the 1987 season. In particular, the ATCM demonstrated a large right bias and nearly always weakened the storms with time. These effects were particularly noticeable in the ATCM forecasts of Typhoon Lynn in October, 1987.

Experiments are being performed to isolate the reason(s) for these ATCM forecast errors. A new version of the ATCM has been developed which incorporates some of the features of NOGAPS 3.0. These include a 15-level optimum interpolation analysis and an increase in the number of model levels from 12 to 21 in order to include a high resolution planetary boundary layer. In addition, the cumulus parameterization has been modified so that the ATCM can maintain the tropical storm circulation during the forecast. Also, sensitivity experiments are being conducted to find the best structure of the initial bogus and to study the effect of increasing the horizontal resolution.

Navy Tactical Applications Guide (NTAG), Vol. 6

(Fett, R.W., NAVENVPREDRSCHFAC)

An effort is now underway to develop a series of examples demonstrating the use of high quality satellite data for analysis and forecasting in the tropics. Both polar orbital and geostationary satellite data are used to study the evolution of certain weather effects or of a particular weather phenomenon at a given time. These examples are intended for publishing in the NTAG Volume 6, Part I, Tropical Weather Analysis and Forecast Applications, and Volume 6, Part II, Tropical Cyclone Weather Analysis and Forecast Applications. NTAG Volume 6, Part I was distributed in June 1986. Part II is still in the research process. Publication is anticipated in 1988/89.

Tropical Cyclone Condition Setting Aid for Sasebo and Iwakuni, Japan

(Jarrell, J.D., Sci. Appl. International Corporation)

A forecast aid has been developed for predicting tropical cyclone associated winds at Sasebo and Iwakuni, Japan. The aid consists of two parts. The first part is a collection of charts which relate winds observed at the two stations to the maximum sustained winds at the center of a tropical cyclone as a function of cyclone locations. The second part of the aid is a collection of diagrams which estimate the worst case arrival time of 50-kt winds.

Improvements to Combined Confidence Rating System

Harry Hamilton (ST Systems, Monterey, CA)

The Combined Confidence Rating System (CCRS) has been improved via a redesign of its weighting function. The new weighting function is derived from the following: the inverse of a covariance matrix which is a combination of the historical cross-track and along-track covariance matrices, and the objective aid forecasts. The weights are generated as follows:

a. Let Q_x and Q_y be the cross-track and along-track covariance matrices, respectively. The desired combination of these two, Q, is equal to $Q_x + aQ_y$, where a has been determined empirically to be 0.25.

b. The weight for each available objective forecast technique is the sum of all terms of the relevant technique divided by the sum of all terms of Q^{-1}. The sum of the weights for all available objective techniques must equal 1.0.

The Combined Confidence Weighted Forecast (CCWF) is generated for JTWC by summing the selected objective forecasts used in the calculations.

Automated Tropical Cyclone Forecasting System

(Tsui, T.L., Miller, R.J., and A.J. Schrader, NAVENVPREDRSCHFAC)

The Automated Tropical Cyclone Forecasting (ATCF) system is an IBM PC compatible software package currently being developed for the Joint Typhoon Warning Center (JTWC). ATCF is designed to allow JTWC forecasters to display graphically tropical cyclone forecast information, merge and analyze synoptic wind fields, provide objective fix guidance, select optimum objective forecast aid, and expedite the issuance of tropical cyclone warnings. One great advantage of using ATCF is the standardization of the tropical cyclone forecasting procedure, so that during the course of the tropical cyclone warning preparation, forecasters will not neglect consideration of any decisional steps or available options. ATCF automatically saves all tropical cyclone data, computes the real-time and post-storm statistics, and allows forecasters to randomly access any past storm data. A communication package included in ATCF simplifies the data transfer procedure between JTWC and Fleet Numerical Oceanography Center in Monterey, CA.

The ATCF will be installed at JTWC in January 1988 for test and evaluation. Modifications on the system will be followed to make the system be compatible with the design of the JTWC Automation Project.

North Pacific Tropical Cyclone Climatology

(Miller, R.J. and T.L. Tsui, NAVENVPREDRSCHFAC)

A tropical cyclone climatology for the North Pacific has been developed and now is being reviewed by EGPACOM. Data used for the western basin were taken from the JTWC Tropical Cyclone Data Base and covered a period of 40 years, 1945-84. Eastern basin data spanned the 34-year period from 1949 to 1982 and were obtained from the consolidated worldwide tropical cyclone data base at National Climatic Data Center, Asheville, N.C. Storms for both basins were sorted according to month/day of the year into twenty four 31-day overlapping periods. For each period, four charts are supplied: 1) actual storm paths; 2) mean storm paths; 3) average storm speed; and 4) storm constancy and frequency.

JTWC has evaluated and offered suggestions for modifications of the climatology. The final version of the compilation should be completed in March 1988.

EOF Post-Processing Forecast Technique

(Tsui, T.L. and J.H. Chu, NAVENVPREDRSCHFAC)

NEPRF is adapting the Empirical Orthogonal Function (EOF) post-processing tropical cyclone forecast scheme developed by Naval Postgraduate School (NPS) on the Fleet Numerical Oceanography Center computer system. The NPS EOF technique objectively recognizes the salient patterns of large-scale horizontal wind fields with respect to the center of a tropical cyclone. This information, in terms of the EOF coefficients, will be used to modify the tropical cyclone track forecasts produced by the numerical models. The skill of this method is derived from the regression equations between the EOF coefficients and the forecast tracks of the One-way Tropical Cyclone Model (OTCM) in the western North Pacific during the period from 1979 to 1983.

2. JOINT TYPHOON WARNING CENTER

Joint Typhoon Warning Center Automation Project (JTWC-AP)

LT Brian J. Williams, USN, Typoon Duty Officer, JTWC Automation Officer.

A comprehensive effort is currently underway to provide JTWC with state-of-the-art, automated tools to aid the Typhoon Duty Officer (TDO) in the collection, presentation, and analysis of data. These tools will also streamline the production of the warning messages and provide decision-making aids for the TDO. Automation of JTWC will take place in two phases. The first phase is the implementation in January 1988 of the Automated Tropical Cyclone Forecasting system (ATCF). The ATCF consists of a "suite" of program modules designed to run on IBM-AT compatible microcomputers. The concept and design of the ATCF (described above by Dr. Tsui and Mr. Miller) is a cooperative effort between NEPRF and JTWC. The second phase of automation will be the implementation of the more comprehensive JTWC-AP in FY 89. The JTWC-AP will integrate features of the ATCF with a more complete advanced data base archival and retrieval system, satellite imagery looping, overlay, and increased emphasis on expert systems that make the TDO's watch routine more efficient and effective.

The hardware suite that will run the ATCF programs (described above by Dr. Tsui and Mr. Ron Miller) has five workstations connected by a file server network to share common data files (see Figure 6-1). A dedicated terminal will provide the send/receive interface with the Automated Weather Network (AWN). Numerical forecast aids, FNOC analyses and prognostic fields, as well as near-real time synoptic data (as a back-up to the AWN) will be received via remote requests over the TYMNET public data network. The TYMNET connects the JTWC microcomputers to FNOC mainframes. Outgoing messages to customers without access to AWN are inserted into the AUTODIN system via paper tape sent to the local Navy Telecommunications Command Center (NTCC). The ATCF software and hardware implementation represents the first step toward automation of JTWC.

A major feature of the future JTWC-AP will be the **reference roster** data base. This data base will contain critical data about customers in JTWC's AOR. It will include storm haven information, telephone points-of-contact, notification criteria for threatened customers, geographical information, local area forecasting rules of thumb, weather reporting station locations, etc. Whenever a customer is threatened, the reference roster will automatically prompt the TDO with customer-specific information. JTWC is currently working to compile the data reference roster for the JTWC-AP project manager. The reference roster will be easily edited to add or delete information as conditions change. This feature should significantly improve the level of support to JTWC's customers.

Another important feature of the JTWC-AP is a training or playback mode which will call up archived data to realistically recreate

previous forecast scenarios. This will be possible due to the integration of satellite imagery, numerical analyses, prognostic fields, and "raw" data into one data base "tagged" by time, geography, or event (*e.g.*, a tropical cyclone). This feature will provide the ability to display, analyze and recreate the timing of receipt of all data that was available for a past storm. This will allow a controlled training environment, especially in the off-season, as well as an outstanding tool for forecast "bust" reviews. In addition, this function will provide a complete and rich data base for post-analysis, case studies, and other research.

Future plans for the JTWC-AP include the implementation of decision-making aids (such as decision trees developed at the Naval Postgraduate School) and expert systems to aid in forecasting genesis, motion, intensity and dissipation. The JTWC-AP will provide a comprehensive real-time and archived tropical cyclone data base as well as the tools to manipulate data. This system is expected to significantly improve JTWC's operational support, while providing an excellent means for studying, improving, and "fine tuning" tropical cyclone forecasting methods and operational procedures.

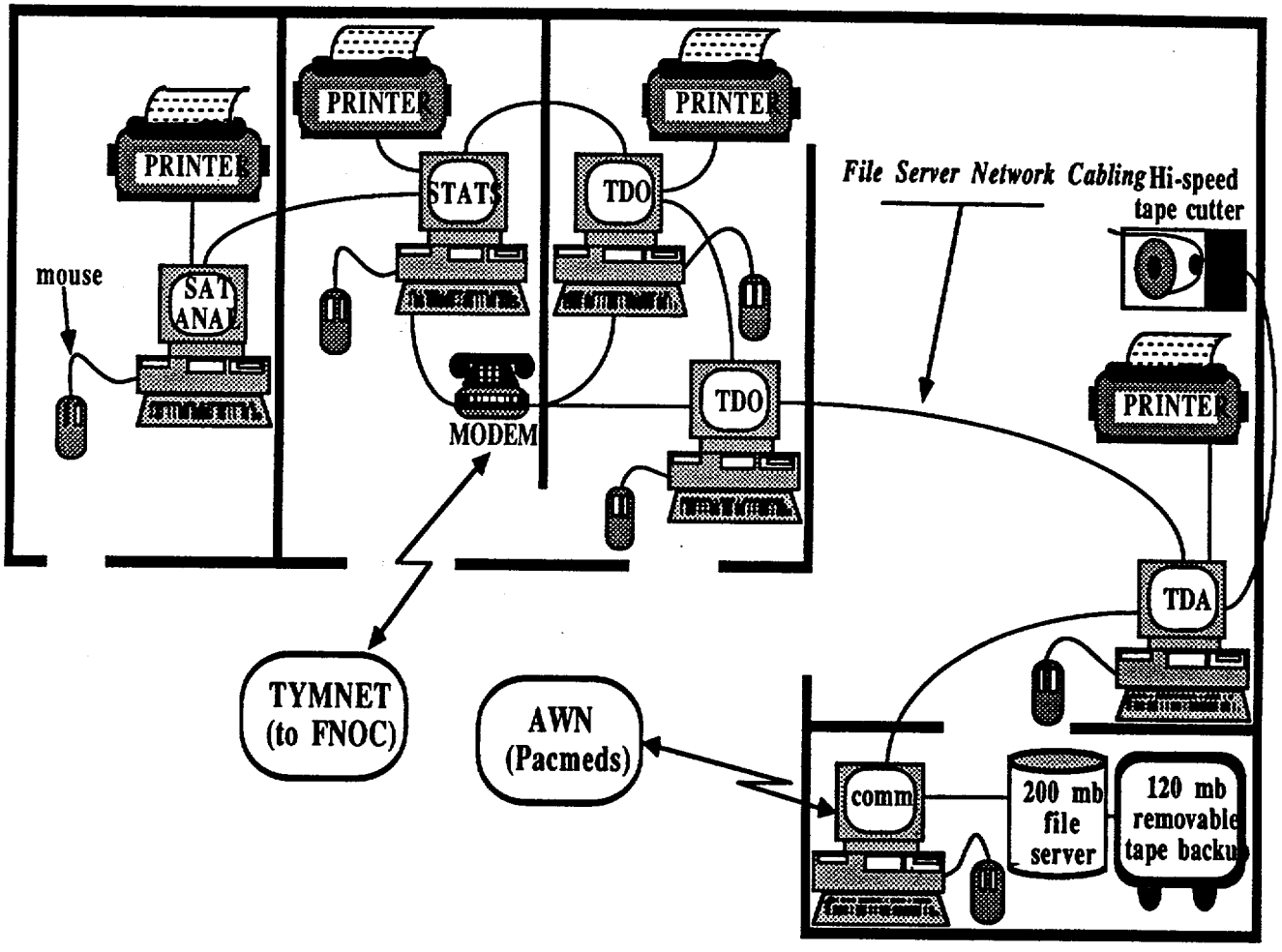

Figure 6-1. Physical layout of the ATCF in JTWC's working spaces.